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REPORTS ON THE CLASSES, PREPARED BY ORDER OF THE COMMITTEE OF COUNCIL ON EDUCATION.

APPARATUS AND PROCESSES OF THE ART OF MINING AND OF METALLURGY.

BY WARINGTON W. SMYTH, M.A., F.R.S.

The peculiar subdivision and classification of subjects adopted by the French Imperial Commission have introduced into the work of the juries in 1867 sundry anomalies, which would have been avoided by a less transcendental system. At our own Exhibitions of 1851 and 1862 the apparatus and the products of the arts of mining and metallurgy were conveniently classed together; whilst on the present occasion the miner and metallurgist found his raw materials and his products (in Class 40) entirely cut off from the processes and implements by which he is accustomed to work them, and the two divisions severally grouped with other classes, which in the real conduct of his business have no connection whatever with his own pursuits. This inconvenience could only be partially remedied by arrangements made by the secretaries of juries to pass certain of the objects exhibited from one class to another. In this manner the geological maps and sections, which ought to be regarded as the records of the exploratory labour upon which the work of the miner is to be based, were placed, in the building and by the catalogue, in Class 13, along with ordinary geographical maps, but were claimed for consideration by Class 40; whilst those which were on a scale detailed enough for being applied directly to the purposes of mining were taken up, along with models of mining localities, into the department of Class 47. Similarly, it was agreed between the secretaries that the refractory substances, including plumbago or graphite crucibles, fire-bricks, &c., several groups of which had been exhibited in our class, should be transferred for the consideration of the jury which dealt with materials of construction in general, and which already had ranged under its numbers a long list of exhibitors of bricks, terra-cotta, and refractory materials.

In what belonged properly to Class 47 the English portion of the Exhibition was exceedingly meagre; and neither alone, nor taken in conjunction with the display in Class 40 (minerals and metals), could it pretend in the remotest degree to represent the greatness and the activity of mining and metallurgical life in the United Kingdom. The causes of this deficiency will readily suggest themselves to the minds of those who know our English works, and need, I think, no examination or discussion in these pages. But it is of the highest importance that, whilst our own producers decline so generally, from one cause or another, to enter the lists, we should enquire whether they can properly repose at a distance in fancied security, enwrapped in an atmosphere of self-satisfied superiority, or whether they ought not to be on the *qui vive* and preparing for fresh efforts, on seeing the examples which appear to mark an extraordinary degree of advancement on the part of our foreign competitors.

I propose, therefore, to invite attention chiefly to those objects which are likely to excite the interests of our own masters, overlookers, and workmen, in comparing what we know at home with that which is doing on the Continent.

MODELS AND PLANS OF MINING LOCALITIES.

Some of the most remarkable works of this class are those which illustrate the complicated structure of that important coal field which extends from the Belgian frontier through the Department du Nord and far into the Pas de Calais. The French Ministry of Public Works has exhibited the map (on a scale of 1 to 25,000) constructed by M. Dormoy, with sections attached to it taken across the breadth of the trough, and showing the position and thickness of the troublesome overlying bed of watery ground called the *torrent*. The map of the Pas de Calais, drawn up by M. Coince, is perhaps still more noticeable, as showing on a larger scale (1 to 10,000) the energy and system with which, by means of an elaborate series of borings, all of them accurately recorded, the development of a valuable new coal field has been accomplished within a very few years. It was only in 1846 that a boring for water at Oignies, not far from Douai, gave evidence of the continuation of the coal measures beneath the cretaceous strata in this direction. The borings of the Escarpelle Company proved, as was pointed out by M. Du Souich, that the coal formation was sharply deflected north-westward from its old direction at Valenciennes; and hence arose, between 1850 and 1864, the establishment of 19 new concessions, 17 of which are in the Pas de Calais, and extend within that department over a length of about 35 miles. Some 40 pits have already been sunk, having, on an average, 100 to 150 metres of overlying formations to pierce, and down to depths of from 180 to 300 metres for their workings.* The amount annually produced from this new and unseen district of coal has increased steadily from less than 5000 tons in 1851 to upwards of 1,600,000 tons in 1866.

Plans of a most accurate character, on a scale of 1 to 5000, have been prepared from the elaborate surveys of M. Grüner to represent the conditions of the still more valuable but old-established coal field of the Loire, generally known by the name of its chief town, St. Etienne; and a beautiful model, founded upon the maps of the same engineer, has been constructed by M. Lesseure, to exhibit the singular curves of the great seam of Rive-de-Gier, in the same district. This so called *grande masse*, varying from 26 ft. to above 50 ft. in thickness, has been so far explored as to enable all its folds and faults and other accidents to be shown with great minuteness, the small portions which are still uncertain being left blank.

The works thus emanating from the Ministry teach us a useful lesson in connection with the commercial history of France. Not even the rich and advantageously situated beds of Rive-de-Gier could be worked with profit so long as insufficient capital and a low state of technical knowledge prevailed. The hampering of the coal miners with the claims of the surface owners, the undue subdivision of the ground, and the inattention of the Government to the treatment of what was truly a large question, had, between 1832 and 1838, brought the district to the verge of ruin. Most of the collieries were losing money, numbers of them were being successively drowned out, and the prospects of the future were miserably neglected. The present large annual production of over 3,000,000 tons from the basin of the Loire, and the clear light which is now thrown upon the natural conditions of the district, testify to the new life introduced within the last 17 years by an improved organisation.

Another representation of the surprising progress made by France within a single generation is exhibited by the mining company of the Grand Combe (6, 19, and 31, France). Few, perhaps, of our countrymen who throng in numbers to Nismes and Avignon are aware that in those wild and storm-raged hills above Alais the perseverance of the "industriels" has opened out a coal field which promises to be a most important treasure to the South of France, and is already third on the list of the French coal districts for its amount of production.* The ravine of the Grand Combe is the locality of the most active mining operations; and a very large model, showing all the plications and disturbances to which the basin of coal has been subjected, proves, at the same time, the great amount of exploration done within a few years, and the care with which all ascertained data are recorded. Plans, sections, and books of statistics, beautifully kept, are added for the further ellucidation of the subject; and one point of especial interest to some of our English coal workers will be found in the extension, in several places, of the coal workings far beneath the overlying strata of the Trias.

Several other special localities have been admirably illustrated in the same manner, as the curious seam of coal worked at Creusot (Saone-et-Loire), the mines of the Commentry Company, and the iron mines of Rancie. But, among them all, none are more worthy of observation than the plans of part of the coal basin of Liege, executed by M. Van Scherpenzeel Thim. By means of exact vertical sections which he has construced for that field, to the number of 700, he has laid down the precise position of all the seams throughout a slice of of the coal field of 50 metres deep, selected between the horizons of 140 and 190 metres below the level of the sea, as being that portion of the basin which is of the highest present importance in laying out the practical operations. Between these two horizontal planes he determines the position of each bed at every 10 metres of depth; and, by a shading upon a system of conventional perspective, he has given a graphic representation, which, aiding the lines mathematically determined, presents to the eye a distinct picture of the underground relations of this highly contorted but valuable region.

These various labours testify to the close exactness of work, and to the intelligence of the French and Belgian engineers, as well as to the careful spirit of their respective Governments, in dealing with so important an element of national prosperty. How much would the labours of our recently-appointed Royal Commission of Inquiry on Coal have been lightened and rendered satisfactory had similar documents been available in our coal fields, and had a similar precaution been exercised in registering the results of sinkings and borings, which upon our careless want of system are so often totally lost?

The excellent plans and sections in which the Prussians have recorded their important explorations of Westphalia and Silesia come rather under the head of geological maps, and were reported on at the Exhibition of 1862; but they are not the less worthy of attention from visitors who desire to understand the rapid development of the mineral wealth of these highly valuable districts of coal.

WORKING OF MINES.

The laying out of the general plan of operations in coal mines, and the methods adopted for the actual getting of the mineral, constitute a subject too extensive to be otherwise than partially illustrated in an Exhibition. But, considering how such a subject involves the pecuniary economy of obtaining this mainspring of all modern industry, as well as the security of the hundreds of thousands of men who toil in what is necessarily a dangerous vocation, we may refer with advantage to a few contributions which tell us somewhat of the processes used in France and Prussia.

The days are quite past and gone when the coal workings of these countries were petty and incomplete, and commonly feeble imitations of English originals. The great annual amounts now raised by them —12,000,000 tons by France, and 23,000,000 tons of coal and brown coal together by Prussia—suffice to show that an enormous trade has arisen, and that an experience has been gained both by directors and workmen which has led to much independence of design and process. It has not been without difficulty that so considerable a development has been brought about within so few years, especially in the bringing up of a large population competent to deal with a new task; and in certain districts particularly, as in the department du Gard, the mining companies have had to take in hand all the details of social organisation, as if planting a colony in a desert land.

It may not be generally known that the coal fields of Central and Southern France, although individually of small extent as compared with our own, are remarkable for the occurrence of seams of extraordinary thickness. The tolerably regular beds of coal at Blanzy and Montceau run to 50 ft. and even 60 ft. thick; that of Creusot, where it is raised up into a vertical position, varies from a few feet to 50 ft., 80 ft., and as much as 130 ft., measured right across; and the great seam of Decazeville (Aveyron) often extends to 100 ft. in thickness. Their very magnitude, to say nothing of their often distorted position, entails on the workers a variety of difficulties, which it has taken a great number of years successfully to surmount. One method after another has been tried, and many successive improvements have been introduced, chiefly tending to guard against crush and creep, alike destructive to the getting of coal of fair size and dangerous to the life and limb of the workmen. At last, by common consent, it is allowed that the only full and satisfactory method of getting the largest quantity of coal and of ensuring safety to the men is that of systematic "packing" or "stowing" of all their bords, stalls, or gobs—of all excavated places, in fact, except the needful roads—with rubbish (*remblais*), carried down from the surface for that purpose. A night shift of men, the *remblayeurs*, are occupied with this task whilst the colliers are absent from the mine; and in some districts a particular shaft and line of roads and special wagons or tubs are set apart for the work. I am glad to be able to bear witness, from inspection at Montceau and at St. Etienne, how methodically the complete packing is carried out, and how it forms a surprisingly good roof to work under when the next stage below it is attacked. It would be out of place here to enter into the details of the arrangements under which this process is securely followed; but the large block model of the Creusot collieries may be mentioned as showing very fully the curiously irregular position of one of these seams; and the model in the midst of the iron productions of Commentry as illustrating the means of working away the successive horizontal ranges of the thick coal bed of that locality, by the aid of a close packing. A question of this kind can only be fairly judged by reference to the figures obtained from actual experience, which tell of its relative economy. A great expense is undoubtedly incurred; for we believe that, in some pits, as many as one-third of the men are engaged as *remblayeurs*. But it would appear that, considering the saving in timber and round coal, and the comparative immunity from accidents, the French engineers have reason to be satisfied with a system which is the growth of many years of study and practical trial.

It is notorious that a chief reason of the inability of the French ironmasters to rival in cheapness their English competitors is the considerably higher price which they have to pay for coal. The reasons for this are manifold. Whether timber propping or stone packing is employed in the pits, it is necessarily in much larger proportion than in our more favourably conditioned English and Welsh coal seams. A French collier, as a general rule, can only get in a day's work from half to four fifths of what an English hewer will break down. It is only in the pillar-working *(depilage)* of the thick seams that the French workman obtains an advantage, and can get as much as 6 or 7 tons in the day; but for this task he needs a special skill and experience, and earns a much higher wage than the average.*

Owing, again, to the irregularity of the seams, a far larger comparative cost falls to the item of dead-work; and for the same reason the underground transit remains generally on a very inferior footing to that of our first-rate British collieries. Moreover, the total number of people employed about a coal pit in France has to be exceptionally large for a given out-put of mineral, in consequence of the general need for carefully cleansing or washing the coal. It is thus only marvellous that, considering how a numerous working population has had to be educated to a peculiar class of labour, the amount of coal raised in France has risen from 1,800,000 tons in 1830 to close upon 12,000,000 tons in 1865. The high civilisation of the country needs, however, a much larger amount, and the importations of 1865, chiefly from Belgium, amounted in coal and coke to about 7,100,000 tons besides.

Up to the advent of railways our neighbours across the Channel had, in fact, developed their coal fields to a very trifling extent, and their knowledge of the practical art of mining stood at a low point; but since that period the general advancement of trade and manufacture has been kept pace with by the opening of new means of transit, by the association of capital in large companies, and by the constant improvement of the methods and apparatus of working. As far as I have had the opportunity of forming an opinion, the working colliers are generally inferior to our own in working energy, but superior in steadiness; and a great part of the credit for the present active and intelligent conduct of the French coal trade is due to the excellent technical training received by the superior officers and managers at the schools at Paris, and so usefully afforded, in a different degree, to the class from which the sub-officers are taken, by the local mining schools of St. Etienne and Alais.

The Prussian authorities have exhibited several instructive models, representing their methods of excavating the seams of more moderate thickness in the Sarrebruck coal field—pillar workings as well as a variety of long-wall, some following the level course, others the rise of the strata. Another representation of particular interest shows the removal, in one working, at the Konigs Grube, Upper Silesia, of the Sattel-flotz, a seam about 24 ft. thick. The bords or stalls are driven 15 ft. wide, with pillars of 20 ft. between them; and the getting of the upper part of the seam is aided by the use of door-frame sets of timber of great height, which would entail heavy expense, unless a large portion of them can be recovered.

By no means the least interesting part of the Exhibition, in connection with the daily life of the French colliers, is the indication offered by some of the largest colliery companies of the efforts made to improve the moral and material condition of their workpeople. Anzin, near Valenciennes, exhibits models and a series of plans of colliers' houses built by the company; and Blanzy (Saone-et-Loire) has erected in the ground a full-sized house, of a patern largely adopted in that district. Some years ago the French coal proprietors adopted the plan of building barricks near their pits, in which a number of people could be lodged on a small area; but the pitman have shown so decided a preference for independent houses, and, if possible, for a bit of garden, that during the last 30 years pit villages of a very superior kind have been formed. It has been a prime object to attach the men to their localities by giving them comfortable cottages at a nominal rent, infant schools and primary schools for their children, and a pension† when incapacitated for work; whilst it has also been sought to remove, as far as possible, the temptation of public-houses, which in Belgium, and in many places nearer home, are a perfect curse to the working collier, and keep him in poverty, notwithstanding his good wages. The outcrop of the coal measures near Blanzy and Montceau is dotted with several colliers' villages, overlooking a pretty valley. The houses are mostly two and two, surrounded by garden and court, each man having about 160 square yards of ground allotted him. Some of the miners, of a provident disposition, aspire to plots of land, and to building houses of their own. The company has, therefore, purchased a tract upon which it grants building lots, and advances money to its workmen for building purposes, charging them no interest as long as they are engaged in the mines. The scheme has been attended by considerable success; and the rising village of Bois-roulot, if not as regular and as well arranged in some respects as those built by the company, is, at all events, a serviceable means of lodging a tolerably large population, and a testimony to the steadiness of the men.

Within the last few years careful experiments, conducted by the Administration, have proved, what was long doubted, that France possesses coals excellently adapted for sea service; and for some time past no other than French coal has been used in the Imperial Navy. But for these purposes the fossil fuels from different localities have to be judiciously selected and mingled in certain proportions. Taking the coal as a whole, it is noticeable that it makes much more small

* One pit—that of Ferfay—has its workings at the depth of 460 metres.

* The yearly production of the coal field of the Gard is now above 1,200,000 tons.

* The daily wages made by French collieries in the central coal fields are from 3s. to 4s., according to the nature of their work.

† The Anzin Company numbers at present, pensioned workmen, 358; pensioned widows, 455: in all, 811; besides assisting 218 orphans.—*Burat, Les Houilleres de la France*, 1867.

and dust than our own, and is more frequently apt to be "dirty," or mixed with shale and clay. It hence results that the French coal-masters have been driven to pay a special attention to methods of cleaning their prodece and utilising the "slack," *menu*, or small coal. At the Great Exhibition in 1851 Berard's coal-washing machine came before us as a novelty, although it was only in certain details that it could rightly be so considered; and, besides several contrivances for that purpose introduced more recently, a great variety of ingenious apparatus has been brought into use for making "patent fuel," *agglomeres—i.e.*, for pressing the small coal into cakes of various forms, by the aid of a small amount of some binding material. These *briquettes* are highly reported upon for naval use; in their carriage to the ports there is a loss of only 1 per cent, against from 6 to 10 per cent. on lump coal; and when stored abroad they are found after two years' exposure scarcely at all injured, whilst ordinary coal would have suffered to the extent of 50 per cent. Moreover, they are very free from ash, and may be made of a mixture of flaming and of dry coal, or of those varieties which have a more free-burning and a more calorific property respectively, in such a ratio as to give the best effect in getting up and maintaining steam. The present Exposition abounds with examples of the machinery and the products of this manufacture; and, although we are not in Great Britain without a similar industry, attention may fairly be called to the subject in the interest of the millions of tons of small coal and of interior qualities which we are every year actually getting rid of as refuse.

As early as 1833 Messrs. Marsais and Ferrand took out a patent for this purpose, but it was not until 1843 that the agglomerated coal began to be produced in any quantity, and some years more elapsed before the machinery was so far improved by several different engineers as to lead to the present large scale of manufacture. The St. Etienne Company exhibit a model of their apparatus as employed at Givors, where, by introducing an enormous hydraulic pressure, they need only to add 5½ per cent. of pitch (*brai sec*) to solidify the mass. The stack of rectangular blocks left outside the St. Etienne shed in the "park" throughout the heavy rains of April gave good testimony to the thorough compactness and durability which had been thus attained.

The greater part of the French makers appear to have adopted the circular arrangement of the Messrs. Revollier, and of Mr. Evrard and M. Dehaynin. A beautifully finished model is exhibited by the company of La Chazotte (M. Max Evrard, engineer), having sixteen cylinders, disposed as the radii of a circle, in which the slack, after being heated by a current of steam, and mingled by very ingenious apparatus with the pitch, is pressed by pistons, and formed either into cylindrical or hexagonal blocks, of convenient length. The rate of production appears to be in practice 10 tons per hour with one machine (of which La Chazotte works four), requiring an engine of 50-horse power to work it, and the extreme limit of pressure being 100 atmospheres.

The prices of the St. Etienne compressed fuel are high; the first quality, which contains only 2·10 per cent. of ash, is marked at 28 f. per ton; the second, with 5 per cent., at 26 f.; whilst the best block coal rules at from 19 c. to 23½ f., and the small at 9½ f. to 15½ f. The very small proportion of gas tar, or pitchy matter, introduced into the mass at this work can scarcely be considered as a general guide, since different qualities of coal will need some more and some less of binding material.

M. Felix Dehaynin, a producer of no less than 175,000 tons of *agglomeres* in the year, exhibits (in Class 10) drawings of the Evrard machine as modified by himself, and employed at his three works, in which 500 people are engaged. The company called the "Ocean," at Paris, are also exhibitors of drawings and of the apparatus for the same purpose, known by the name of its inventor, M. Mazeline.

As an adjunct in these operations, an ingenious machine by Hanrez and Co. (Belgium, 12) may be noticed. It is constructed for the drying of small washed coal by the revolution of a screw within a revolving perforated cylinder, and is stated to dry 5 tons per hour.

We could wish that coal workers, mineral landowners, and capitalists would note these various indications of what is becoming in France an important trade. Without being unmindful that several companies have been established in South Wales and elsewhere for a similar manufacture, we cannot but be conscious that their action is but an infinitesimal set-off against the wholesale waste of slack that takes place in this country. It is not only that the small coal cut and broken from the saleable part of seams is in most of our districts thrown into goaf and gob by the tens of thousands of tons, but those portions of beds, often some feet in thickness, which are intermixed with stone or "sulphur," or which make a larger than usual proportion of slack, are at once rejected as useless, and acres of such coal are abandoned, to be inextricably mixed up with broken roof and heaving floor, although of no worse quality than would be turned to advantage in many a French colliery. It is impossible in the hard competition of the times to blame individuals for this sin against the economical use of Nature's gifts; but it is a discredit to the country at large, and will, among our descendants, entail many an anathema on the selfish stupidity of their forefathers.

BORING, ROCK-DRILLING, AND COAL-CUTTING MACHINES.

All the world has heard of the artesian well of Grenelle; not many among the general public are aware of the striking success of the still deeper well of Passy, and but few are acquainted with the fact that at the present moment two undertakings of the same kind, on the grandest scale, are in course of execution—one in the suburb of the Chapelle, in the extreme north of Paris, by Messrs. Degousee and Laurent; the other at the Butte aux Cailles, in the extreme south of the city, by Messrs Dru (formely Mulot and Dru). These two firms, both noted for a great number of successful borings, exhibit an interesting assortment (57 and 58, France) of the apparatus which they employ for holes of diameters varying from 4 in. up to more than 5 ft.

The experience already acquired in supplying a portion of the French metropolis with excellent water tapped from that great reservoir in the strata of the green sand, hundreds of yards below the surface, has led the authorities to contract with thorough confidence for a further supply from the same bountiful source, and to commence the operations on a larger scale than before. In the absence of any great work of the same kind in London, we may remind those interested in hydraulic engineering of some of the chief features of the boreholes already executed:*—Height of surface above the level of the sea at Grenelle, 121·3 ft. English; at Passy, 305·2 ft.; depth of bore-holes at Grenelle, 1800·7 ft.; at Passy, 1923·7 ft.; internal diameter of tube, or lining of hole, at Grenelle, approximately, 9 in. to 6 in. at bottom; at Passy, 2·4 ft. The full diameter of the Passy bore-hole was 1 metre, or 3·28 ft. English; the new ones are to be, in one case above 5 ft., in the other about 4 ft.; whilst it is proposed to pierce, not only to the water-bearing stratum, or *nappe*, already proved to exist, but to a considerably greater depth, in order to cut other feeders which probably abound in the subjacent measures.

It is a pleasure to be able to testify to the scientific knowledge and the business-like method which are applied to their task by the conducters of these two interesting operations. Both are alike in some general respects, such as the use of rigid rods only, in preference to rope; the employment of steam to work the rods; and the erection of a lofty pulley-frame, or derrick (*cherre*), in one case 52 ft., in the other 68 ft., high from the ground to the axis of the main pulley. But in the details considerable variations are noticeable. The free-fall cutter, for the use of which these eminent bore-masters are strong advocates, is made to detach itself by a different device, the movement is differently communicated from the steam-cylinder to the walking beam, and there are sundry other variations worthy of study. At the time the British juror and his deputy were courteously met on the spot by Messrs. Degousee and Laurent the work was unavoidably standing; but various of the implements were put together and lowered and raised to show the facility with which the heavy weights are dealt with. Engineers who visit the Exhibition only will be able to form some opinion of the nature of the work on seeing the great tower-like tube of riveted iron plates, 1 centimetre thick each, but doubled, which forms a tall, black background to the well-arranged group of tools and models in the gallery of machinery.

At Messrs. Dru's bore-hole the depth, at the end of April, was near upon 500 ft.; the depth cut in the last working day, in chalk and flint, was 94 centimetres. The weight of the boring tool is about 2 tons 18 cwts. The rods are for the most part of wood, with iron connections; and a length of 20 metres, consisting of two rods of 10 metres each, is raised or lowered at a time.

The magnitude of these operations for artesian wells is greatly exceeded as regards diameter and, therefore, weight of apparatus, by the remarkable boring of actual shafts, which has in several cases been successfully completed by Herr Kind. It is a matter of notoriety that the sinking of deep pits through difficult ground is, upon the ordinary, and even the most approved system, a wearisome and expensive task. In the North French coal field it is estimated by Burat that a capital of 120,000*l.* is expended in the opening of a colliery fitted to raise 100,000 tons per annum; and the examples of Douchy and Aniche were cited, in each of which a still larger proportion of capital has been laid out. A serious part of this, amounting roughly to about half, is due to the sinking and fitting of the pits. And we know that, in consequence of the difficulty of piercing through the strata overlying the coal in Durham, sums of 40,000*l.*, 60,000*l.*, and even, it is said, 100,000*l.* have been expended on a single shaft. We have now, for the future, when so much of our most accessible coal has been exhausted, in a great measure to look to workings further in "the deep" for further supplies, and to shafts sunk through greater depths of Permian and other superjacent formations; and with us, as on the Continent, the problem of sinking with more rapidity and economy is one of the highest moment. We would, therefore, point to No. 53, France, as well deserving of the gold medal which was awarded by the jury, and of careful attention from colliery viewers. The coal company of St. Avold and L'Hopital (the Moselle) have under that number exhibited diagrams of the results at which they have arrived, and some of the actual apparatus employed in the sinking of pits through a great thickness of watery New Red Sandstone, which overlies the coal measures. The system, we should premise, is not altogether new. Some years ago both Kind and Mulot had undertaken to *bore* shafts of diameters of from 10 ft. to 16 ft., through ground whose "running" nature, like quicksand, prevented the application of the usual modes of pumping out the water and establishing the casing, technically called a "tubbing," based on firm and water-tight strata. The excavation was, therefore, carried on by the borer *a niveau plein*, or with the shaft full of water; and the chief difficulty lay in the jointing, at last, of the iron or wooden lining with the firm ground at the bottom. M. Chaudron, a Belgian engineer, devised for this purpose a sliding piece at the bottom of the tubbing (the whole of which is gradually lowered as the excavation proceeds), on the bottom flange of which, turned outward, is a packing of moss, *boite a mousse;* and, when this latter comes to rest on the seat cut for it by the boring tool, the tower of tubbing, hitherto suspended from above, rests by a corresponding flange on the moss, and so squeezes it together and against the side of the pit as to make a tight joint, after the completion of which the water can be pumped out and the sinking commenced in the common way. Such is the bare outline of the method. Concrete *(beton)* may have to be run in behind the tubbing, and many other modifications adopted for insuring a perfect separation between the water in the pit and the world of waters outside.

Already, in 1860, a signal success was attained by M. Chaudron in sinking an air-shaft at Peronnes, where the watery beds had extended from the 43d metre to 105 metres deep; and M. de Vaux, Inspector-General under the Belgian Government, reported in 1861 that the work was executed for less than a quarter of what it would have cost under the ordinary method.

A very ingenious addition of M. Chaudron's is a shield or diaphragm of sheet-iron temporarily fixed near the bottom of the tubbing, and having a large pipe or equilibrium-tube in the centre, in which the water can rise, and through which the boring-rod passes down, having expanding arms which open out below the shield, and excavate the ground. By this means the weight of the tubbing, which at Peronnes was about 88 tons, was so balanced as to throw only about 19 tons upon the rods employed for its suspension.

At St. Avold two pits have been thus triumphantly sunk, of which the sections are exhibited. No. 11 pit was sunk through 426 feet of permeable red sandstone, *grès vosgien;* the final wedging-curb was fixed at 523 ft. deep, on May 1, 1866, and coal was found on April 4 last at 1036 ft. The second pit (No. 12) was so far complete that the "moss-box" was successfully laid, on Feb. 3 last, at the depth of 521 ft.

The large models of the tubbing and shield, with the gigantic boring-cutters *(trepans)* of above 13 feet across, will support this slight sketch in calling attention to an innovation which has been attended with a high degree of practical success, and which may hereafter facilitate the development of untold wealth.

Whilst for years past the vertical boring of deep holes, *sondage*, has been aided by the application of steam machinery, numerous inventors in all countries have attempted to solve the problem of applying the same power to supersede hand labour in the miner's daily task of boring holes for firing charges of gunpowder. The common operation, indeed, of drilling by borer and hammer small holes of from 18 in. to 3 ft. deep, by which at present all our hard rocks have to be blasted is exceedingly laborious, slow, and expensive. Those engineers who have attempted to ignore the value of powder, and to cut the hard stone bodily away, have always failed lamentably. Others have endeavoured to imitate the action of the present hand borers or drills; but the attempts hitherto made in this country to introduce the apparatus into mines have resulted only in delay and disappointment. There are, however, now in the Paris Exhibition two or three inventions which have passed the ordeal of practice, and have actually been employed in the daily service of mines. Since M. Sommeiller's successful application of single borers, each driven from its own cylinder by compressed air acting on a piston, a number of modifications of his general arrangement have been proposed, and it is to some of these that the attention of miners may be specially invited.

Mr. Doering, of Ruhrort, in Westphalia, mounts his machine on a horizontal arm projecting from a heavy iron carriage, which can be run to and fro on the rails in the level or gallery. The machine itself, consisting of a double-acting cylinder with piston, is, by means of pivoting and the motion of the horizontal arm up and down a vertical standard, capable of being set in any direction and at any height required. The drill, or borer, is attached by a key to the piston-rod, and is then, by the action of compressed air, projected and withdrawn several hundred times a minute against and from the surface of the rock, being turned through a small angle after every blow. A jet of water is constantly squirting into the hole for the removal of the debris, and so forcible and rapid is the action that I have seen several inches thus bored into a block of hard granite in five minutes. The bit, or cutting edge, of the tool may be varied; but the reversed Z shape—thus, Z—as at Mont Cenis, is preferred, and it is found that it is blunted far less rapidly than when worked by hand with the blow of a mallet. And now for its practical application. One of the jurors, M. Max Braun, director of the great zinc mines of Moresnet, near Aix-la-Chapelle, under the Vieille Montagne Company, stated to us that eleven of these machines, three of them on the newer construction, have been in actual use there; and that in a level in strong dolomitic rock, where they used to drive by hand-labour 1½ metre in 14 days, they have with the machine made an advance of 3 metres, and sometimes even 4 metres in the same time, and with only two men instead of six. The advantage, therefore, in the economy of the great standard expense of mining work is so obvious as to require no comment.

Another machine meriting attention for the same reasons is the "Bergborr maskin" of M. Bergstrom, exhibited by the mine of Persberg, in Sweden. The stand for it is a strong bar, with steel point at the bottom, and steeled holders regulated by a screw at the top; and as the boring cylinder traverses up and down the bar, this latter must be fixed by the aid of cross timber, in a direction parallel to that of the intended bore-hole. The drill is then made to act by compressed air in the manner generally similar to the last, although there are considerable differences in the construction. The weight of the whole apparatus is only 120 lbs., and it may thus easily be moved from place to place, although open to the objection of giving more trouble in the fixing. The very machine which is exhibited is stated to have worked for 700 days underground, and to have bored 1000 metres. When tried upon hard granite it has bored 2 metres in the hour; and, as in Doering's machine, the "bit" has been found to last five times longer than when struck by hand.

A third modification of this general type is the machine exhibited by General Haupt, an American. It is mounted between two upright bars, which are fixed between floor and roof, and thus does not admit of the same scope of direction as Doering's. The movement of the piston and drill is effected by steam; but whilst the jury were making their inspection it never could be brought into steady action. The valve arrangements are particularly ingenious, and the moderate size and weight of the apparatus are in its favour. A highly laudatory pamphlet accompanies this "perforator" to Europe, but does not contain any distinct statement of the machine having been actually employed in mining operations.

A very beautiful horizontal cylinder-engine is exhibited by M. De la Roche Tolay, engineer of the Chemin de Fer du Midi, intended to bore the rock by a rapidly rotating drill, forced forward by hydraulic pressure of about 1540 lbs. Various forms of cutting drill have been experimented on, but the only one which appears to have given good results in hard rock is the diamond-mounted rings of M. Leschot. And, however preposterous it may sound to apply the valuable gem to the boring of holes in granite and quartz rock, visitors to the Exhibition may see it actually perform its works with considerable rapidity, and observe from a large drawing on the wall near it how it is proposed to arrange several of these machines at once for attacking a tunnel face. The boring implement is tubular, and admits a jet of water through the middle into the hole; its face, of soft iron, is studded with eight pieces of black diamond, carefully hammered up, and the incomparable hardness of the adamant encounters with such success the hardest materials of common rock that the engineer states the cost of the abrasion of diamond for a hole of half a metre deep to be under twopence. Very many experiments have been made at surface, but it is not asserted that the machine has been subjected to practical trial underground.

The tunnelling machine, by Captains Beaumont and Locock, R.E., impelled by compressed air, and looking a "*monstrum horrendum ingens*," has already attracted much attention from visitors to the gallery of British machinery. It is a heavy, powerful means of projecting against the face of the rock a disc armed at its circumference with 36 borers, which, gradually turning with the disc, cut an annular groove, whilst a central borer at the same time drills a hole of equal depth, which is afterwards to be charged with powder and fired. Whatever engineers may think of it for abbreviating the labour of tunnelling, it is too cumbrous, and, for various reasons, inapplicable for ordinary mining.

There is yet another machine to be mentioned which has done good service in economising labour and in preventing waste in the marble quarries of Rutland county, Vermont, U.S. It is the invention of Mr. Wardwell, and is exhibited in full size, in the outer shed of the United States department, by the Steam Stone-Cutter Company, of New York. The machine, propelled by a small steam-engine of 4-horse power, consists of a carriage of 5 ft. in width, carrying on both sides a series of vertical bars armed with cutters, which notch out a groove of the required depth, instead of its being cut by the picks of the quarrymen. It is asserted that in these extensive quarries, where many hundreds of men used to be employed, the action of this machine in reducing the labour cost and saving the marble, by the narrowness and greater accuracy of the cut, has been eminently satisfactory.

COAL-CUTTING MACHINES.

Of far greater importance to this country are the attempts which for several years have been made to replace by machinery the labour of holing, kirving, or undercutting the seams of coal. The purely mechanical operation of cutting, by means of a light pick, a groove of from 2½ ft. to 4 ft. deep along the face of coal which is to be removed is not only slow and laborious, but wasteful, as cutting into slack a considerable amount of the seam; and, forming as it does the chief item of expense in the excavation of the coal, it has of late been more seriously forced upon the attention of coalowners by the irregularity and strikes of the workmen, which have so often brought the operations of the coal mines to a ruinous standstill.

The earliest of these machines which may be pronounced a success is the pick machine of Messrs. Firth and Donisthorpe, worked by compressed air. I had the advantage of seeing it doing excellent work by way of trial in 1863, at Hetton; and I am informed by Mr. Lindsay Wood, now managing that great colliery, that two of them have been daily at work for upwards of four years, and that they have given entire sasisfaction. More of them would have been employed but for the difficulties which arise in practice of adapting to them a special mode of work which shall also suit the particular character of the roof. Two newer machines are exhibited at Paris, which deserve special notice. Messrs. Jones and Levick, of Blaina (Great Britain, 8) have constructed a very portable carriage, movable along rails by a hand-wheel, and mounting a pick at any required height in the seam, so carried in a revolving head-stock that instead of only striking horizontally, as in most of the earlier inventions, it may be applied to any angle of inclination in which the seam lies. A pressure of 30 lbs to 37 lbs. is applied through flexible tubes, and from 60 to 70 blows per minute are given, with a result, when all is in order, of undercutting to the depth of 3 ft. or 3½ ft. along a length of 9 yards to 15 yards in an hour. This would appear, on the face of it, to be a substitution for a great number of men; but other important advantages are gained. A better proportion of large coal is obtained; and, the holing groove being very much less high in the front than where the hand-pick is employed, a comparatively small quantity of coal is cut into slack.

These advantages are also shared by the machine of Messrs. Carrett, Marshall, and Co., of Leeds (Great Britain, 3), a more complicated apparatus, the chief feature of which is a strong steel bar, armed with three cutters or scoops, and forced by hydraulic pressure against the coal in such wise as to form the undercut by a sort of planing action oblique to the face. Instead of passing three times along the front of the coal, as do the pick-machines, in order to cut inward to the required depth, this contrivance completes the full depth at once, and without percussive action, or making dust and noise; it moreover cuts through iron pyrites and bandstone with facility. Mr. J. Liddell, of Newcastle, has kindly informed me that he has had one at work occasionally, and experimentally, for twelve months; that, when in full order, it has cut as much as 12 yards in an hour; but that, from circumstances in the seam of coal, the mode of working, &c., he is not yet in a position to give definite results as to the economy of its use.

It is unnecessary to dwell at length on the various ingenious arrangements which have been applied to these machines, but we may point with satisfaction to the inventions of our countrymen which are likely to aid in maintaining our position as the first producers of cheap coal; and the importance of the subject is further shown by the liberal offers of the colliery proprietors of South Lancashire and Cheshire to give prizes of 500*l.*, 200*l.*, and 100*l.*, for the first, second, and third best coal-cutting machines which shall have been fairly tested by their committee, in trials to commence in November.

COAL PIT FITTINGS.

Whilst our English producers of mineral deemed it not worth their while, for the sake of a medal and a small modicum of glory, to incur the trouble and expense of sending over to Paris the familiar forms of apparatus which they employ, a number of French and Belgian coalowners have forwarded models and full-sized fittings, which, if they have nothing specially new about them, yet play an important part in showing the present position of the mechanical arrangements brought to bear on their mines. Thus, the company of Bethune (Pas-de-Calais) exhibits, in its full size, a stout pit-head frame, with flat-rope pulleys, wooden guides, cages, and tipping arrangements, all of them very similar to examples which we may find at home. The colliery is an interesting one, as being founded on that portion of the northern coal field which has been so skilfully explored beneath its complete covering of the chalk formation, and being advanced to within a moderate distance of the Channel. Here, as in most of the recent establishments, the apparatus is on a good scale, and calculated to serve the purpose of working an extensive area from one set of pits. The Blanzy Company (Saone et Loire) represent in model another form of wooden frame, housed in, with a neat belfry-like roofing even over the sheaves or pulleys. A more novel construction is represented among the excellent collection of the collieries of the Loire (St. Etienne, &c.), placed in a special building in the park. The leg, beams, stays, and shedding are all

* See report of M. Cassagnes, Portefeuille Economique des Machines, Dec., 1864.

of wrought-iron, as erected at the pit of St. Louis in 1864. A different system, that of building the main beams as cylinders of sheet-iron, riveted together, had in 1862 been adopted at the pit Jabin, and after four years of work stands perfectly well. The magnificent pit-head frames of the Forster pit, at Seaton Delaval, are known amongst us as a good example of wrought-iron applied to this purpose, but the economy of the use of the metal as compared with wood is not yet fully proved. The French fittings in wrought-iron have been tried, and the observation of the engineers that, in their districts, six years are sufficient to render unserviceable the common head-stocks of pine: whilst ten years bring even oak to such a condition as to require expensive repairs. Pit ropes are exhibited of various forms and material. The heavy flat-ropes of aloe fibre are much employed in the North of France and in Belgium, where some of the shafts are of greater depth than any in our own country.

In the better collieries of both the above countries cages of a construction similar to those of our northern pits are very generally employed for the conveyance of the tubs or wagons up and down the shaft. Many of these are exhibited in full size, some of them two-decked, to carry two tubs or wagons on one floor; others, for narrow shafts, having four tiers or decks for one tub each.

M. Libotte (Belgium, 16) shows cages for six tubs—one with two tiers of three tubs each; the other, of very awkward length, of six decks. The former weighed, when constructed, as usual, of rolled iron, 3960 lbs.; the latter, 4180 lbs. Simultaneously with what is being substituting steel for iron, in order to reduce the dead weight, and thus brings his new steel cages for the carriage of the same amount of coal to the more moderate weights of 2200 lbs. and 2640 lbs. respectively.

Ever since the Great Exhibition of 1851 numerous inventors have turned their attention to the subject of providing the cages with safety-catches, intended to grip the guides in case of the breakage of the rope. In 1855 and 1862 a long list of contrivances had to be referred upon, but, even up to the present day, the opinions of those most conversant with pit machinery are divided on the question of which of them, if any, is preferable to simply doing without them, if only due caution be exercised in employing the very best material, and frequently overhauling the rope. It is matter for regret that some of our English inventors appear this time in the field, since Fallow, Owen, White and Grant, Aytoun, and others, have devised various ingenious modes of attaining this important object, and many of our English pits have been thus fitted for years past. There was nothing new to see on the present occasion. One of the oldest, and theoretically perhaps a rather objectionable form, that of Fontaine, is still shown as in use at the great Anzin collieries, and merits respect from the number of lives it has actually saved. Jacquet, of Mons, and others, exhibit a clutch acting by a toothed eccentric, similarly to that of White and Grant; and M. Nyst, of Belgium, his system of applying a pair of iron forks to trapezoidal wooden guides. M. Krauss, of Prussia, also exhibits what appears to be a good modification. Where the speed of winding is moderate, as in many of the continental and of our central and southern collieries, several of these varieties may do good service; but where the great velocity of Lancashire and the North is in vogue, the tendency of the clutches to come into play during the rapid descent is very troublesome, and even dangerous.

Among safety-lamps for fiery collieries several of the known modifications of the Davy are exhibited, and among them sundry contrivances for more effectually locking them than by the common method. A new one is that of M. Arnould, of Mons, who so inserts an iron pin that the lamp can only be unlocked by placing it in a proper position over the poles of a powerful magnet, and thus puts it out of the power of the men to expose the flame. Unfortunately, however, as we have too sadly seen in some of our late colliery accidents, all these precautions may be rendered utterly futile by the determination of colliers to carry lucifer-matches in their pockets for the ready getting a light when, against all rules and all prudence, they choose to strike it.

For the ventilation of mines nothing new has been proposed since 1862. But there are placed along with the fittings of the French collieries models of fine examples of the ventilators of Fabry, of Lemielle, and of Guibal, the last two of which are now introduced with success into some of our English coal districts.

DRESSING, OR MECHANICAL PREPARATION OF ORES.

A variety of apparatus in this department is exhibited, little of which is characterised by novelty. The company of Fives-Lille (France, 55 and 87), whose engineers are Messrs. Huet and Geyler, make a considerable display in the gallery of machinery of circular revolving tables, jigging-hutches, &c., of iron, not without merit, and of some novelty to France, but following very closely the models of the well-known Prussian manufacturing house at Deutz, near Cologne. The Austrian mining administrations of Przibram and Schemnitz have sent drawings and models of a number of useful inventions for the dressing of silver-lead and of gold ores. Most of them are the production of Mr. P. von Rittinger, whose able services in this direction have gained him a European reputation; and they have been already known and commented upon at former Exhibitions. Our mining agents and engineers may, however, study with advantage the models which tell of his efforts to obtain continuous, instead of interrupted, action, especially in his jigging-machine, and in the side-action percussion frame or shaking-table. Of the latter contrivance two examples have been recently erected at the mines of the Vigra and Dingan Mining Company, North Wales, where they act admirably in separating the metallic sulphides, which occur along with the gold in their St. David's lode.

Amid the sad collapse and pressure which have for the last year or two weighed so heavily on our British copper and tin mines, simply in consequence of the large amount of these ores which have been cheaply raised in distant countries, it is to be regretted that neither in this department nor any other of the actual processes of mining is our insular industry represented.

APPARATUS EMPLOYED IN METALLURGY.

Omitting to notice several models of blast-furnaces, which offer no important feature of novelty, I should remark that the exhibitors from several different countries show that more attention is being bestowed on the economy of heat, and on the utilisation of inferior fuels, by the introduction of gas-furnaces, and of apparatus of the class of the regenerator of Messrs. Siemens. Some of the more interesting of these were contributed by Sweden, especially the elaborate model of M. Lundin, showing the method by which he obtains the inflammable gases from wet sawdust (which in vast quantity has hitherto in that country been a waste product), frees it from watery vapour, and then applies it to a steel-furnace, to brick-kilns, or other purposes. Lundin's arrangement would be applicable to the burning of such materials as wet peat, inferior coals, and lignites, which are of very little or no value when tried on common fire-bars.

Among the extensive collections exhibited by Schneider and Co., of Creusot, in a special building in the park, some large drawings are well worthy of observation which illustrate the excellent arrangement of the enormous mills and forges and machine-making departments of that establishment. Some of the jury of our class, indeed, concluded (and it was the only subject on which we had a considerable divergence of opinion) that the distinguished Vice-President of the Chamber of Representatives ought to receive a grand prize for the success which had attended his efforts to produce from materials of only moderate quality manufactures of great excellence; and they held that the judicious arrangement of the various groups and divisions of the work contributed in no small degree to the economy of his finished products. And it was certainly no light argument to point to the building, out in that remote south-eastern portion of France, of a whole army of locomotives for a British railway!

The French ironmasters have for years past enjoyed a reputation for the rolling of good qualities and particular forms of iron. In 1855 the capital iron girders which were being abundantly employed in the erection of common street houses aroused the interest of many of our jurors; and now in 1867, the works of Chatillon and Commentry, and of Petin, Gaudet, and Co. distinguish themselves by the finest examples of rolled girders and plates that have been seen. To understand, in fact, how some of these beams of 1 metre high, and with very broad flanges at top and bottom, had been so well and evenly rolled, it was necessary to see the model exhibited by the former company (France, 88), showing on a small scale the complex arrangements of their universal mill—*laminoir universel*. Messrs. Marel Freres, the well-known makers of many kinds of machinery, exhibit a rolling-mill of the same elaborate character. It is placed near the boring apparatus of Degousee and Laurent. M. Wagner, the director of the works of Mariazell, in Styria (Austria, 5), also furnishes, although on a much smaller scale than the last, the model of a rolling-mill for the same purpose, as devised by himself. No doubt many of the products turned out by these machines, and shown in the Champ de Mars, may fairly be considered *tours de force;* but we cannot withhold from the French iron producers the credit of having attained by their skill and perseverance to a high grade of excellence.

STEAM-ENGINES FOR WINDING AND PUMPING.

If there were any one department of machinery in which we Englishmen used to think, a few years ago, that we had it all our own way, it was the construction of steam-engines. And although it might be conceded that taste was to be found across the Channel, and that good designs might be produced, and, perhaps, even light work executed, by French and Belgian engineers, still it was confidently asserted that for heavy work and for powerful engines they must come to England. A glance at the Paris Exhibition will dispel these illusions, and teach us that machine makers and designers have arisen who have made good use of a sound education in mechanics, and who are competent to cope with the tasks daily brought before them by the progress of engineering.

Several large winding-engines for collieries are brought before us in full size, and exhibit the types which are now attached to some of the first-class works. Thus, M. Quillacq has erected an engine with two coupled vertical cylinders in front of the pit-frame of the Bethune Company, the piston-rods acting directly on the shaft of the drum or rope-roll. Belgium has sent two double-cylinder engines, each, like the last, of about 200-horse power. Both these—that exhibited by the Chatelineaux Company and that of MM. Dorzee and Andry (Belgium, 19 and 6)—have their cylinders mounted on a pyramidal iron framing, and working downwards upon the rope-drum, which is placed at the level of the ground. Something may be gained by this mode of construction in the economy of the engine-house, but several reasons might be adduced in favour of the opposite system, generally followed at our large collieries, of planting the cylinders low and mounting the drum above. These engines, as also the well-finished, powerful horizontal machine exhibited by the Creusot Company, are fitted with a special cylinder for a steam brake, and sometimes with an apparatus for arresting, independently of the engineman, the progress of the cage on its going dangerously high in case of inattention. One of these contrivances, a long horizontal screw, along which a carriage travels as the cage ascends, was already exhibited in 1862 by the maker, M. Gouteaux, of Gilly.

Some modifications of pumping-engines, which evince much ingenuity, are exhibited in drawing by M. Colson (Belgium, 5), but their merits can scarcely be pronounced upon without observation of their effectiveness in practice. The French engine-maker, M. Quillacq, of Anzin (Nord), not only exhibits his productions in drawings and actual engines, but excited the incredulity of some of the jury by a statement that he had supplied both pumping and winding steam-engines to an important Newcastle colliery. That such a Gallic invasion of our great centre of colliery operations should have taken place without some special reason or private arrangement appeared highly improbable, and I at once communicated with the owner for the purpose of obtaining the explanation. It is but justice to the French engineer to state that the order for the direct-action pumping-engine which he supplied was given simply in consequence of his lower price and better finish as compared with the tenders from English houses. It has now been at work above 18 months, and I quote the particulars kindly sent me by the owner, in saying that "it has given the greatest satisfaction," and that "the construction and the quality of material and workmanship are very good." This has led to the order of a pair of winding engines for the same place, which are also "highly satisfactory." Here we have, then, one of our Newcastle mines actually working by means of French-made machinery, fairly brought in by open competition to the midst of our machine shops and foundries; and when we look at the inland position of Anzin, and the unquestionable disadvantages which have to be combated in a district where coal and iron are comparatively dear, I cannot but think these results redound to the credit of French engineering, and inculcate on ourselves an important lesson.

FOREIGN MINING AND METALLURGY.

The rolling mills of the Haute Marne are restricting their production, and a certain number of their workpeople have been paid off. Prices are so low that they cannot well be reduced further, but, nevertheless, this does not secure a return of activity. Charcoal-made pig is quoted at St. Dizier at 4*l.* 6s. 8d. per ton, but this quotation is to some extent a nominal one. There is an uneasy feeling among the business men of the district, although it would be difficult to say exactly why this is the case. Coke-made pig of the Meurthe district is offered free at St. Dizier at 2*l.* 18s. 9d. per ton. At a meeting of forgemasters of the Moselle district it was decided to reduce prices; white refining pig is now offered at 2*l.* 12s. to 2*l.* 14s. per ton; there is a considerable stock, and it is believed that it may become necessary to extinguish more blast-furnaces. Out of 46 puddling-furnaces, owned by two Ars houses, there are now 32 in activity. In the works of M. de Wendel, the only works stopped are some at which a mechanical puddling apparatus, which is stated to yield very good results, is being fitted. A contract is about to be let in the Moselle for about 1800 to 2000 tons of cast-iron piping, intended to conduct the waters of the Corze to Metz; the contract was recently taken by a Moselle establishment, but it was cancelled by consent. A letter from the Ardennes states that a turbine of considerable power is being equipped at Brévilly; as soon as the work is completed it is proposed to add to two rolling mills already at work at this point three new rolling works, two of which are to be applied to the rolling of zinc. This last arrangement, in a locality in which only iron and plates have yet been rolled, has attracted some notice. The French administration of telegraphic lines recently put in adjudication 500 tons of galvanized iron wire, which was let at an average of 18*l.* 15s. 10d. per ton. The average price obtained at a similar adjudication, which took place in Dec., 1866, was 20*l.* 17s. 9d. per ton. The Marseilles Gas Lighting, Blast-Furnaces, and Foundries Company, with which is associated the Portes and Sénéchas Mines, paid on Oct. 1 the balance of the dividend for the exercise 1866-7, or 10s. 10d. per share. The Douvrin (Pas-de-Calais) Colliery Company paid on Oct. 1 interest for the exercise 1866-7, or 1*l.* per share. The Montrambert and La Beraudière Collieries Company will pay on Oct. 16 a dividend for the first half of 1867, or 4s. per share. The St. Etienne Collieries Company will make a similar distribution on the same day. Meetings are announced as follows:—St. Eloi (Puy-de-Dôme Collieries and Railway Company), Oct. 10, at Paris; Naval and Railway Blast-Furnaces, Forges, and Steel Works Company (Petin, Gaudet, and Co.), Oct. 14, at Lyons; Andalusian Copper and Lead Mines and Foundries Company, Oct. 17, at Paris; and Vicoigne Mines Company, Oct. 28, at Valenciennes.

The metallurgical crisis so long complained of in Belgium is stated to be becoming more and more aggravated. At Liége prices are low, and orders far from abundant. From Charleroi it is reported that, notwithstanding the extinction of numerous blast-furnaces, and the stoppage of several rolling-mills, the establishments in activity do not find it possible to run off their production. Among foreign outlets, Belgian metallurgy must especially keep Russia in view. Already several contracts for rails for this country have been concluded, and new ones may yet be negociated, as a number of lines are in course of construction in Russia, and others have just been conceded. It is a singular fact that it is in Russia only that anything like activity is displayed just now in the construction of public works. It is difficult to fix prices in the Belgian coal trade, affairs being restricted, and everyone selling as he can. The Northern Railway has just brought into operation a new tariff, but the reductions occur only on transports effected beyond Compiègne. In the Couchant de Mons it appears to be quite impossible to fix prices; superior qualities are the only ones which maintain quotations. Several of the contracts concluded by Belgian industrials with Prussian coalowners will soon expire, and it is doubted whether they will be renewed, not because there is anything to complain of with respect to the German coal, but because local coalowners will make all the concessions necessary for them to regain the local market. The Monceau-sur-Sambre Blast-Furnaces Company is paying its first dividend for 1867, or 1*l.* per 20*l.* share. Meetings are announced as follows:—Borinage Rolling Mills Company, October 14, at Jemmapes: Val-Benoit Collieries Company, Oct. 14, at Liége; Selessin Blast-Furnaces, Ironworks, and Collieries Company, Oct. 14, at Selessin; Vesdre Mines and Blast-Furnaces Company, Oct. 19, at Liége; Austrian Company for the Fabrication of Chemical and Metallurgical Products, Oct. 19, at Vienna; Saxon Company for the Manufacture of Steel (at Dohlen), Oct. 19, at Dresden; Central Belgian Rolling-Mills Company, at La Louvière, Oct. 21, at La Louvière (St. Vaast); Austro-Belgian Metallurgical Company, October 21, at Corphalie, near Huy; Centre of Gilly Collieries Company, Oct. 22, at Gilly; John Cockerill Company, Oct. 23, at Seraing; General Water Conduits Company, Oct. 28, at Liége; Phœnix Mines and Ironworks Company, October 30, at Laar, near Ruhrort; and Sars-Longchamps and Bouvy Collieries Company, Oct. 31, at St. Vaast.

The advices received from Chili have weighed somewhat heavily upon the Havre copper market, upon which quotations have receded to 70*l.*, 70*l.* 10s., although the last advices note that 250 tons had changed hands at from 70*l.* 10s. to 72*l.* 10s. The Paris copper market has been heavy, and prices have been but feebly supported upon it; English has made 78*l.* to 80*l.*; Lake Superior, 92*l.*; Corocoro mineral, 78*l.*; and Chilian, 72*l.* per ton. The unfavourable advices from England and France have again caused the principal German markets to become quiet; there has been no important modification in prices at present upon these markets; nevertheless, there is rather a downward tendency apparent in affairs. At Berlin, Cologne, and Stettin former prices have been sustained. As soon as the result of the recent Dutch public sale of tin became known the markets for that metal, relieved of the uncertainty of expectation, regained a more regular aspect, with a decidedly upward tendency. The quantity presented for sale at Rotterdam by the Society of Commerce was 70,031 blocks of Banca and 445 blocks of Billiton; Banca was taken off at 54¼ fl., and Billiton at 53¼ fl. This result has been favourably received, and has generally inspired confidence. At the last dates Banca was held at 54¾ fls., and Billiton at 53½ fls. Annexed is a comparative table, showing the deliveries of Banca tin on the Dutch market during the last three years:—

	1865.	1866.	1867.
Deliveries from Jan. 1 to Sept. 30 ..... Blocks	103,442 ..	118,705 ..	84,066
Stock on schedules, Sept. 30	132,169 ..	199,259 ..	187,549
Unsold stock of the Society of Commerce, Sept. 30.	43,344 ..	34,554 ..	1,654

Tin has improved in price on the French markets. At Paris, Banca is quoted at 100*l.* to 101*l.*; Straits, 95*l.* to 96*l.*; and English, 96*l.* per ton. At Marseilles the quotation for Banca has been 96*l.*, and for English 98*l.* per ton. In presence of current circumstances, the article is maintained firmly on the Hamburg, Berlin, Cologne, and Stettin markets. An application for a concession of mines of tin and other metals situated in the hamlet of Montrebas, in the commune of Soumans, in the arrondissement of Boussac (Creuse), has just been made by the Montrebas Tin Mines Company, whose office is at Paris. There is no movement of importance to notice in lead; the demand does not display any very great activity; but, nevertheless, the tone of the markets is good, and prices are generally maintained without difficulty, the supplies on the principal markets being inconsiderable. The advices received from Hamburg with regard to tin are satisfactory; the demand is active, and some rather important affairs have been concluded. At Breslau zinc has been quiet, no important transaction having been noted. Notwithstanding the good tone of the London and Hamburg markets, there has been only a moderate demand for zinc at Paris.

FOREIGN MINES.

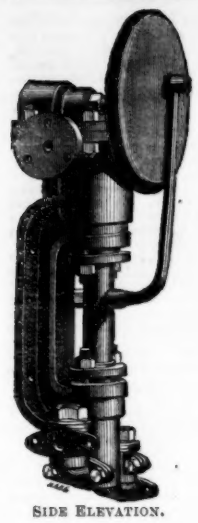
ALAMILLOS.—Sept. 28: The lode in the third level, east of La Magdalena shaft, produces ½ ton of ore per fathom; this level is now holed to Moran's winze, and we are now opening on the north part of the lode. In the third level, east of San Enrique, the lode is open and easy, producing ½ ton of ore per fathom. The lode in the fourth level, east of La Magdalena shaft, produces 3½ tons of ore per fathom. The lode is very rich in the bottom of the end, but the upper part is not so good. The fourth level, west of La Magdalena shaft, produces 3½ tons per fathom; this is opening a splendid run of tribute ground. In the fourth level, east of Taylor's engine-shaft, the lode is regular, but quite unproductive. The fourth level, west of San Andriano shaft, contains good stones of lead, but not enough to attach a value to. The lode in the third level, west of San Andriano shaft, has failed lately, and the ground is harder for driving. In the second level, east of Crosby's cross-cut, we are opening in the south side of the level to prove a part of the lode standing there. The lode in the second level, west of Crosby's cross-cut, is improving; it produces 1 ton of ore per fathom. In the third level, west of Crosby's engine-shaft, the lode, which is worth ½ ton of ore per fathom, is split into sundry small branches.—Shafts and Winzes: The ground in Taylor's engine-shaft, below the fourth level, is hard, and the men are getting down at a slow rate. In Riva's winze, sinking below the third level, the lode is small and poor. The lode in Verdu's winze, below the third level, west of La Magdalena shaft, is very strong and productive; it yields 1½ ton of ore per fm. The tribute department has yielded very well during the past month, and the stopes continue fairly productive. The machinery is in good working order, and the surface work throughout the mine is going on very regularly. We estimate that the raisings for the month of October will be about 225 tons.

LINARES.—Sept. 28: West of Engine-Shaft—South Lode: The lode in the 110, west of engine-shaft, has improved during the last few days, and is now opening tribute ground; it produces 1 ton of ore per fathom. In the 95, east of Taylor's cross-cut, the lode is very wide, containing spots of ore.—North Lode: In the 90, east of Taylor's, the lode is large, composed chiefly of carbonate of lime and lead ore, worth ½ ton per fathom.—Shafts and Winzes: No. 154 winze, below the 85, produces 1 ton of ore per fathom; the lode has greatly improved, and is of a very kindly appearance. The tribute department produced a fair average quantity of mineral during the past month, and no unusual change has taken place in the appearance of the stopes throughout the mine. We estimate the raising for October at 275 tons.

FORTUNA.—Sept. 28: Canada Incosa—West of Taylor's Engine-Shaft: The 100, west of O'Shea's shaft, is without change. The lode in the 90, west of Henty's shaft, produces 1½ ton per fathom; it is not quite so good as it has been, though it still continues to open good tribute ground. In the 80, west of Judd's, the lode is very irregular; it now produces ½ ton of ore per fathom.—East of Engine-Shaft: In the 70, east of Carro's shaft, there is no change since our last report, but we are expecting to find the cross-course shortly, to the east of which we expect a good lode; the lode now yields 1 ton of ore per fathom. The lode in the 55, east of Carro's shaft, is small and unproductive. The lode in the 55, west of Santo Tomas, produces ¾ ton of ore per fathom. We are daily expecting to communicate this end with Rubio's winze.—South Lode: In the 40, west of San Pedro shaft, the lode is large and regular, composed of quartz and lead ore, worth ¾ ton per fm. In the 30, west of San Pedro shaft, the ground is easy for driving, and the lode has a very kindly appearance, producing 1 ton of ore per fathom. In San Pedro shaft, below the 40, the men are making good progress, and we hope to get deep enough for the 50 next month. There is a slight improvement in Gil's winze below the 40 since our last report; the lode now produces ¾ ton of ore per fathom.—Los Salidos Mine: In the 100, west of engine-shaft, there is no change. The lode in the 90, west of engine-shaft, is very irregular, and is at present divided into several small branches; it produces ½ ton of ore per fathom. The lode in the 75, west of Buenos Amigos, is not so good as it has been, but it still presents a very promising appearance, and produces 1¼ ton per fathom. The lode in the 65, west of San Carlos, is compact and regular, producing 1 ton per fathom; the ground is hard. In the 100, east of engine-shaft, the lode is small, letting out a large quantity of water, and producing ½ ton of ore per fathom. The 90, east of Cox's, presents no change since last report. In the 75, east of Cox's, the lode is regular, composed of quartz, intermixed with lead ore. The 65, east of San Miguel, has become quite unproductive. In San Pablo's shaft, below the 65, there is an improvement; the lode now produces 1¼ ton of ore per fathom. We have commenced sinking Buenos Amigos shaft below the 75; the lode produces 1½ ton of ore per fathom.

PONTGIBAUD.—W. H. Rickard, Oct. 1: Roure: The 125 metre level, south of Richards's engine-shaft, is unproductive. The rise in the same level north is holed, and the driving of the level resumed. The 80 metre level south is poor. The 60 south opens good ground, worth 1¾ ton of ore per fm. The 40, south of Agnes' shaft, is in a lode composed principally of hard quartz, without any ore to value. The adit south of Richards's shaft is in crushed ground, and poor. The stollen south is in speedy ground; the lode is poor. The stollen cross-cuts west have met with no change. The stopes in this mine are without any notable change, as are also the tribute pitches.—La Grange: The lode in the 80 is cut through: it shows a width of 15 ft., composed principally of hard, jointy quartz, containing mundic and lead ore, worth for the latter about 1½ ton per fathom. The lode in the 60 north, where undercut, yields saving work of low quality. The 20 south is without change; the ground is soft flookan. The same level north is poor. The stopes in the back of the 60 and 40 metre levels yield their usual quantity of low quality stuff. The tribute pitches are just the same in yield as for some months past.—Mioche: The driving of the adit south of railway is temporarily suspended, and the men put to sink to prove the branches of ore we drove through some months ago. The clearing of the adit north, on No. 6 lode, has gone on well; we are nearly under the shaft, and hope to hole in a short time. The shallow level, driving from the surface shaft, opens tribute ground worth ½ ton per fm.—La Brousse: Bassett's shaft is sunk to the 80 metre level, and the cutting of the plat commenced. The 60 metre level south yields 2 tons of ore per fm. The 40 north is unproductive. The 40 south yields 1 ton per fm. The 40, on the eastern part of the lode, yields 4 tons per fathom. Our tribute pitches continue to yield well.—Pranal: The 50 fm. level north, on St. Matthew's lode, yields 1½ ton of ore per fm. The same level south yields 1 ton per fm. The cross-cut east is in speedy ground. The 30 metre level north yields ¾ ton per fm. Our tribute pitches yield very fairly on the whole.—Surface: We have had from 20 to 25 men working at the Caravaux laveries during the past month, have completed the wall against the river, and are now busily working at making the wheel-race, which is rather difficult, having a great deal of rock to cut out. Our sampling for the past month was 256¾ tons.

ICE IN DEEP MINES.—The main entrance to the pits at Dannemora, Persberg, one of the oldest and most celebrated of the Swedish iron mines, is a natural opening or abyss, of so large a circumference as to require some fifteen minutes to walk around its mouth. A scaffold is erected out, so as to overhang this abyss, upon which the hoisting machinery is placed. The observer can look down into this frightful abyss upwards of 500 ft., to which point the light of day extends, and beyond which all is shrouded in darkness, save when feebly illuminated by the dim lights of the miners. One of the most remarkable facts connected with this mine is the large quantity of ice which is always present there. Prof. Von Leonhard, in his "Popular Lectures on Geology," says—"The deeper you go the more the ice increases. And in order to remove it from the pits it must be raised up in buckets. At some places the ice is 90 feet thick; it forms real glaciers, which are never diminished by any change of external temperature. This fact, however, should not be regarded as contradictory to another, which will hereafter be illustrated, and which is that pits become warmer in proportion to their depth. The phenomenon at Persberg, as we shall see, can be explained on natural principles. When the visitor has reached the bottom he is conducted by his guide into vaulted chambers, through immense regions of ice. Many of these vaults are so large that 50 men can conveniently work in them at the same time." This occurrence of ice in deep mines is not an isolated fact. Ice is found in the pits of Ehrenfriedensdorf, in Saxony. Leopold Von Buch tells us that formerly, in Norway, mining was prosecuted above the region of eternal snow. Wood, for the timbering, could not be had there, and its want was supplied by filling up a drift with water, and allowing it to freeze; passages were then cut through the ice as they were needed, the balance of the ice being left in lieu of wood for timbers. It is also well known that the ancient Peruvians obtained ores on the Cordilleras, in places elevated above the perpetual snow line. The mines of Rauris, in Upper Austria, lie entirely within the glacier region, and most of the shafts open in eternal ice, clear as crystal; the miners' huts are surrounded with ice. On what is known as Gold Mountain one of the shafts is sunk 100 ft. through pure glacier ice. A gold mine in the deep valley of the Alps, near Salzberg, is the highest in Europe which is now worked. There are two tunnels near this mine entirely surrounded with glacier ice. The miners of this region undergo great hardships from exposure to cold, and to avalanches, which often sweep them to destruction while going to and fro to their work, or while reposing in their cabins on the hill sides. It is stated by one authority that there is a locality deep within one of the iron mines of Dannemora, already noted, where the mass of ice is 120 yards thick.—*Mining and Scientific Press (U.S.)*



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THE NEW INJECTOR,

FOR FEEDING BOILERS AND RAISING WATER FOR OTHER PURPOSES.

PROTECTED BY ROYAL LETTERS PATENT, No. 1539, DATED 2d JUNE, 1866.

PRICES, DELIVERED IN LONDON.

Size.	Ram. in.	Stroke. in.	Approx. horse-power boiler supplied.	Approximate gallons thrown per hour. At 100 rev.	150 rev.	200 rev. p. min.	Price.
No. 4	1¼	3	15	115	[illegible]	230	£10 10
5	1⅜	3	22	180	[illegible]	360	12 12
6	1⅝	4	30	240	360	480	14 14
7	2¼	4	40	345	517	690	17 0
8	2½	5½	55	475	712	950	19 10
9	2⅝	5½	75	585	877	1170	22 10
10	2½	6¾	90	720	1080	1440	25 10
11	2¾	6¾	110	870	1305	1740	28 10
12	2¾	8	120	1080	1545	2060	31 10
*14	3	8	230	2450	3675	—	40 0
*16	3¼	8	460	4900	7350	—	55 0

* The two last are double-acting.

Steam Regulator Valves, and also Check Valves, specially made to suit these Engines, can be supplied.

Each Injector is guaranteed to work with perfect efficiency, and the undersigned wish it to be distinctly understood that any one ordered will be sent simply for the buyer's approval, to be returned in the event of its not giving entire satisfaction.

A CIRCULAR, WITH FULL EXPLANATION AND COMPARISONS, WILL BE SENT ON APPLICATION.

FRONT ELEVA

UNDERNOTED ARE A FEW TESTIMONIALS IN FAVOUR OF THESE INJECTORS:—

Grove, Southwark, Sept. 11, 1867.

GENTLEMEN,—In reply to your enquiry, we beg to state that the No. 6 donkey-pump we purchased from you about a year ago was severely tested in our works before being sent out, and gave not only ourselves but the inspector of the machinery we were manufacturing every satisfaction. We trust you will send us the No. 7 pump last ordered as soon as possible.

EASTONS, AMOS, AND ANDERSON.

Port of Dublin Shipyard, Dublin, Sept. 9, 1867.

GENTLEMEN,—We have put your injectors into several steamers fitted out by us, and we are very well satisfied with them. They do their work efficiently, give no trouble to the man in charge, do not get out of order, and are, in our opinion, the best injectors now in use. WALPOLE, WEBB, AND BEWLEY.

Blackfriars Bridge Works, Chatham-place, E.C., Sept. 7, 1867.

GENTLEMEN,—We have been using your donkey-pumps on these works for the last nine months, and I have much pleasure in bearing testimony to their utility and efficiency for feeding boilers and forcing water. F. W. BRYANT.

Hull, Sept. 9, 1867.

GENTLEMEN,—In reply to your favour of the 7th inst., the last injector you supplied to us works well, and to our entire satisfaction.

BLUNDELL, SPENCE, AND CO.

1, *Castle-court, London, Sept.* 9, 1867.

GENTLEMEN,—In reply to yours of this date, I am happy to be able to report that any of your donkey-pumps which I have used have done their work quite satisfactorily. W. MACGEORGE, Marine Consulting Engineer.

North Woolwich, London, Sept. 10, 1867.

GENTLEMEN,—In answer to your note, I beg to say the two injectors you supplied me with are working very satisfactorily. W. T. HENLEY.

Free Trade Wharf, London, Sept. 12, 1867.

GENTLEMEN,—Your injector on our wharf works to our entire satisfaction.

E. BREFFITT AND CO.

Phœnix Steam Block Works, Woolston, Southampton, Sept. 10, 1867.

GENTLEMEN,—We have much pleasure in testifying to the efficiency of your patent injector, now in use at these works. We can truly say it is an admirable little machine. MIST AND DURKIN.

Cement Works, West Hartlepool, Sept. 10, 1867.

GENTLEMEN,—We have had one of your No. 11 injectors at work for the last four months, and up to this time it has given entire satisfaction.

CASEBOURNE AND LUCAS.

Canterbury, Sept. 9, 1867.

GENTLEMEN,—In reply to yours this morning, we had a good deal of trouble to get your injector to work at first. Our engineer had to take it to pieces, and make a new screw to bottom of ram. Since then it has gone exceedingly well, and we are much pleased with it, and should recommend it with every confidence to any person who might require a feed-pump to their boiler as the most simple and most effective we have ever met with. J. J. WILLIAMSON AND SON.

Belfield Print Works, near Rochdale, Sept. 9, 1867.

GENTLEMEN,—We are glad to say that your injector works to our entire satisfaction. THE BELFIELD PRINTING COMPANY.

Ryde, Sept. 6, 1867.

GENTLEMEN,— . . . The patent injector you fitted to my steam yacht, Water Rat, has given me entire satisfaction. I shall have pleasure in confidently recommending it to my brother yacht owners and friends.

FRED. W. ELLIS.

Whitelands Road Mill, Cock Brook, Ashton-under-Lyne.

GENTLEMEN,—The injector we had from you for pumping water gives us every satisfaction. JAMES MILLS.

Culwell Foundry, Wolverham , *Sept.* 9, 1867.

GENTLEMEN,—The No. 7 patent injector purchased from u is in work, and giving every satisfaction. JOS. EVANS.

Star Brewery, Canterbury, Sept.

GENTLEMEN,—The injector supplied me by you in May last continue most satisfactorily, throwing the hot liquor into the boiler from 150° heat. I consider it a great saving in fuel. It has not hung up, or least trouble since the day it was fixed. GEORGE

South Devon Shipping Company, South Devon Wharf, Sept. 1

GENTLEMEN,—I have much pleasure in bearing testimony to the working of your injector furnished to our steam-crane by you, for supp boiler with hot water from the tank. In fact, it is the most perfect thi kind I have ever seen, and I feel assured it will give general satisfact ever it is brought into use. WILLIAM BEER, M

Railway Wagon Works, Darnall, near Sheffield, June 2

GENTLEMEN,—The injector works very well; we are quite satisfie It is a great novelty here. CRAVEN BROS.

Tranmere Foundry, Birkenhead, July 1

GENTLEMEN,—The patent injector gave every satisfaction, and we s to our friend the manager of the Canada Works, who is very much plea it. W. AND M.

Skipton, July 2

GENTLEMEN,—I am glad to inform you that the injector you have me seems to work admirably. I am very much pleased with it. HENRY ROB

Jutland Railway, Locomotive Department, Aarhuus, Aug.

Particulars of trial of pump this day at the above works. Pump Messrs. Brown, Wilson, and Co.:—Diameter of pump, 3 in.; stroke, 6 i sure of steam, 30 lbs.; horizontal draw, 100 ft.; depth to lift, 12 ft.; w charged, 16 ft. above pump. At 220 strokes per minute it lifted 4500 ga hour; at 100 strokes per minute it lifted 2300 gallons per hour.

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No. 80, CANNON STREET, E.C.; AND VAUXHALL IRONWORKS, S., LONDON.

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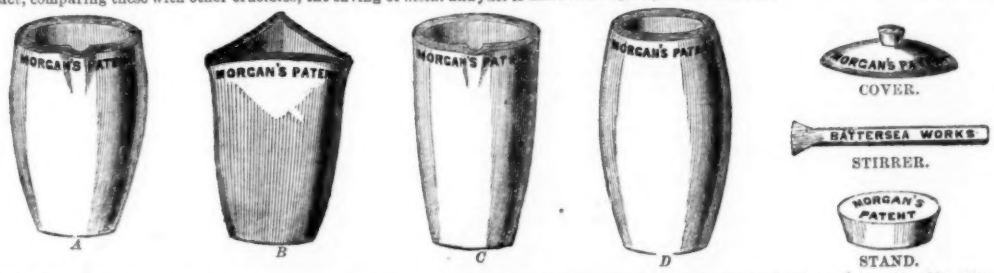
Their quality is uniform. They withstand the greatest heat without danger. Their average durability for Gold, Silver, Copper, and other ordinary metals is forty to fifty pourings, in some cases reaching one hundred. They never crack, and heat more rapidly than any other kind. One annealing only is required. Change of temperature has no effect. They can when hot from the furnace be dipped in cold water with safety. The saving of labour and metal is very great. In *Steel Melting* the saving of fuel has been denomstrated to amount to a ton and a half to every ton of steel used. For *Zinc* they last longer than iron pots, and save the great loss which arises from mixture with iron. Those for *Malleable Cast-iron* show an average working of seven days, doing each day nearly double the work of any other crucible.

As these crucibles last much longer than any others, it follows that the saving of metal must be great, because to each worn crucible a quantity of metal adheres. In fact, comparing these with other crucibles, the saving of *metal* and *fuel* is more than equivalent to *their cost.*



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B differ in shape, but correspond in all other respects with *A*, and are similarly marked.
C are marked in English pounds—thus, a crucible marked 60 will contain 60 lbs.
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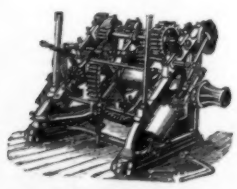
Engineers and Patentees of STEAM CRANES, DONKEY PUMPS, &c.



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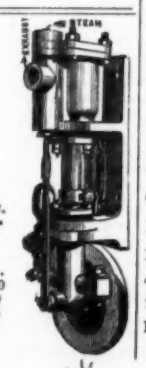
PATENT DONKEY PUMPS.

Ram	1½ in.	2 in.	2¼ in.	2½ in.	2¾ in.	3 in.	3¼ in.	3½ in.	4 in.
*Gall. per hour	230	400	680	850	1200	1500	2100	2500	3800
Approx. H.P.	15	25	40	50	80	95	130	150	220
Price	£10 5	£12 10	£15	£18	£21	£24	£ 28	£30	£35

* Calculated at 200 strokes per minute.



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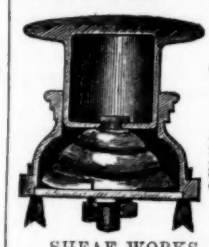
THOMAS TURTON AND SO



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allows of a much greater amount of work being placed before each blas
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